Issued by the Colonial Office

EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

SEVENTH ANNUAL REPORT

1934-35

Crown Copyright Reserved

LONDON
PRINTED AND PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE
To be purchased directly from H.M. STATIONERY OFFICE at the following addresses:
Adastral House, Kingsway, London, W.C.2; 120 George Street, Edinburgh 2;
York Street, Manchester 1; 1 St. Andrew's Crescent, Cardiff;
80 Chichester Street, Belfast;
or through any Bookseller

1935
Price 1*s.* 0*d.* Net

[Colonial No. 110]

88-303-0-35

TABLE OF CONTENTS

	Page
Staff List and Leave Movements	3
Publications	4
Visitors	5
Report of the Director	6
Report of the Plant Pathologist	
Virus Diseases of Plants	12
General	16
Report of the Entomologist	16
Report of the Soil Chemist	
General Soil Survey and Classification	18
Irrigation Problems	22
Miscellaneous	22
Report of the Biochemist	
Insecticides	23
Coffee	25
Acidity and Root Growth in *Coffea arabica*	26
Essential Oils	26
Other Work	26
Report of the Plant Physiologist	
Coffee Investigations	27
Sisal Investigations	28
Report of the Geneticist	
Coffee	28
Sisal	31
General	33
Report of the Systematic Botanist	33
Ornithological Work	37
Report of the Superintendent of Plantations	
Construction and Maintenance	40
Plantations and Nurseries	41
Plant Quarantine	42
Plant and Seed Distribution	42
Report of the Secretary and Librarian	44
Appendix A—Financial Statement for the Year ended 31st December, 1934	45
Appendix B—List of Publications	46

EAST AFRICAN AGRICULTURAL RESEARCH STATION

AMANI

Report for the Period 1st April, 1934, to 31st March, 1935

STAFF LIST.

Director.—W. Nowell, C.B.E., D.I.C., F.L.S.

Plant Pathologist.—H. H. Storey, M.A., Ph.D.

Entomologist.—T. W. Kirkpatrick, M.A., Dipl. Agric. (Cantab.), F.R.E.S.

Soil Chemist.—G. Milne, M.Sc., F.I.C.

Biochemist.—R. R. Le G. Worsley, A.R.C.S., B.Sc., Ph.D., D.I.C.

Plant Physiologist.—F. J. Nutman, A.R.C.S., M.Sc., D.I.C.

Plant Geneticist.—L. R. Doughty, B.Sc. (Agric.), N.D.A.

Superintendent of Plantations.—F. M. Rogers.

Secretary and Librarian.—R. E. Moreau, C.M.Z.S., M.B.O.U.

Botanist.—P. J. Greenway, F.L.S.

Assistant Superintendent of Plantations.—*Vacant.*

Assistant Secretary and Librarian.—W. M. Nutter.

Engineer-Mechanic.—T. V. Greenwood.

Laboratory Assistant (Plant Path.).—R. F. W. Nichols.

Laboratory Assistant (Soil Chem.).—W. E. Calton, B.A., Dipl. Agric.

Stenographer.—(Miss) K. Rushworth.

LEAVE MOVEMENTS DURING THE YEAR.

	Departed.	*Returned.*
Mr. T. W. Kirkpatrick	—	19th October, 1934.
Mr. F. M. Rogers ...	—	16th November, 1934.
Mr. F. J. Nutman ...	8th June, 1934.	23rd January, 1935.
Mr. P. J. Greenway ...	26th July, 1934.	20th February, 1935.
Mr. G. Milne	21st November, 1934.	—

PUBLICATIONS.

The following papers contributed to scientific journals by members of the staff have been treated as Station Memoirs, and separates have been distributed during the year under review :—

Root-Systems of *Coffea arabica*, Parts I and II, F. J. Nutman, *Empire Journal of Experimental Agriculture*, Vol. 1, pp. 271-284 and 285-296, 1933.

A contribution to Tropical African Bird-ecology. R. E. Moreau, *Journal of Animal Ecology*, Vol. 3, pp. 41-69, 1934.

Some East African Essential Oils. R. R. Worsley, *Bulletin of the Imperial Institute*, Vol. 32, pp. 253-270, 1934.

In addition to the above, this Research Station has been responsible for the general distribution of the report of the " Conference on Co-ordination of Agricultural Research and Plant Protection " held at Amani from 12th to 15th February, 1934 (Government Printer, Nairobi, 1934).

The undermentioned papers are awaiting publication or have become available since the annual distribution was made :—

A Synecological Study of the Usambara Mountains, Tanganyika Territory, with particular reference to the Birds. R. E. Moreau, *Journal of Ecology*, No. 1, 1935.

The Insecticidal Properties of some East African Plants. R. R. Worsley, *Annals of Applied Biology*, Vol. 21, pp. 649-669, 1934.

Studies on the Ecology of Coffee Plantations in East Africa, I : The Climate and Eco-climates of Coffee Plantations. T. W. Kirkpatrick, in press. (The Crown Agents for the Colonies.)

Root-systems of *Coffea arabica*, Part III. F. J. Nutman, *Empire Journal of Experimental Agriculture*, Vol. 2, pp. 293-392, 1934. (An advance distribution of this paper has been made to East African Departments of Agriculture.)

The Photodynamic Action of Methylene Blue on the Virus of a Plant Disease. H. H. Storey, *Annals of Applied Biology*, Vol. 21, pp. 588-589, 1934.

A Critical Analysis of the Distribution of Birds in a Tropical African Area. R. E. Moreau, *Journal of Animal Ecology*, in press.

Some Suggested Units of Classification and Mapping, particularly for East African Soils. G. Milne, *Soil Research*, in press.

Some Eco-climatic Data for Closed Evergreen Forest in Tropical Africa. R. S. Moreau, *Journal of the Linnaean Society*, in press.

Cinchona in Amani. R. R. Worsley, *Bulletin of the Imperial Institute*, in press.

A Provisional Soil Map of East Africa. G. Milne, in collaboration with East African soil chemists.

A Short Geographical Account of the Soils of East Africa. G. Milne, in collaboration with East African soil chemists.

Composite Units for the Mapping of Complex Soil Associations. G. Milne. (This and the two preceding papers have been prepared for the International Soil Conference at Oxford, 1935.)

The Extent to which Volcanic Rocks give rise to distinctive soils, examined from East African occurrences. G. Milne.

VISITORS.

Official visitors to the Station during the year include His Excellency Sir H. A. MacMichael, K.C.M.G., D.S.O., Governor of Tanganyika Territory; Mr. C. H. A. Grierson, Provincial Commissioner, Tanganyika; Mr. C. M. F. Swynnerton, Director of Tsetse Research, Tanganyika; Mr. C. Gillman, Chief Engineer, Tanganyika Railways; Mr. W. D. Raymond, Analytical Chemist, Tanganyika; Dr. D. B. Wilson, Malaria Research Officer, Tanganyika; Mr. R. A. S. Macdonald, Deputy Director of Animal Health, Northern Rhodesia; Mr. C. J. W. Pitt-Schenkel, Forests Department, Tanganyika; Mr. R. L. Cornell, Veterinary Research Officer, Tanganyika, and the following members of the Agricultural Departments of contributing territories :—Mr. E. Harrison, Director of Agriculture, Tanganyika; Mr. A. J. Wakefield, Deputy Director of Agriculture, Tanganyika; Mr. F. B. Wilson, District Agriculture Officer, Zanzibar; Mr. C. G. Trapnell, Ecologist, Northern Rhodesia; Mr. J. T. Moon, Agricultural Officer, Kenya; Dr. G. B. Wallace, Mycologist, Tanganyika; Mr. R. M. Davies, Senior Agricultural Officer, Tanganyika; Mr. I. W. M. A. Black, Assistant Agricultural Chemist, Nyasaland; Mr. G. W. Lock, District Agricultural Officer, Tanganyika; Mr. W. V. Harris, Assistant Entomologist, Tanganyika.

The numbers of unofficial and overseas visitors showed a further increase, especially among those making a more or less extended stay for the purposes of consultation or original work. These include Dr. H. Walter and his wife Dr. E. Walter (physiological botany); Dr. and Mrs. H. Kirby (study of termites); Messrs. David Lack and L. S. V. Venables (ornithology); Messrs. P. R. O. Bally and K. Schoner (study of native drug plants); Dr. E. Martin Case (chemistry of coffee); Mr. H. J. Schlieben (botany); Professor Dr. F. Baeyens and Mr. J. Meulenbergh (soil chemistry); Miss G. Riemerschmid (study of solar radiation).

REPORT OF THE DIRECTOR.

Finance.

Reference was made last year to the uncertainty caused by the abolition of the Empire Marketing Board regarding the Imperial contribution to the maintenance of the Station. Information has now been received that the Lords Commissioners of the Treasury have agreed to the continuation of the subsidy from Imperial funds at the same rate (£6,000) in 1935, 1936 and 1937, at the end of which period the situation will be reconsidered. Contributions from the governments of the East African dependencies have also remained unchanged.

In March, 1934, the Carnegie Corporation of New York having " been much impressed by the importance not only to the British Colonies and Territories of East Africa but to Tropical Africa in general, of the East African Agricultural Research Station at Amani ", generously offered a capital grant of £10,000 for the permanent endowment of the Library, subject to satisfactory assurances being given of the continuance of the Station. The offer was accepted by the Secretary of State after consultation with the governments concerned, and the fund has been invested by the Crown Agents in suitable securities.

The accounts of the Kwamkoro Estate (Appendix A) show an estimated profit of about £250 notwithstanding increased expenditure on development and on repairs to the factory.

Of the capital expenditure authorized at Amani, £500 has been expended on the rebuilding of the office block and £130 on a new motor-lorry.

Coffee and Sisal Experiment Stations.

Close relations have been maintained with the Coffee Experiment Station at Lyamungu. The buildings and equipment are not yet completed, but Mr. H. B. Stent, Soil Chemist to the Station, who has been temporarily accommodated at Amani from October, 1933, was able to transfer his work at Lyamungu in April, 1935. Further coffee plant selections made by the Amani Geneticist have been sent for trial. The Amani Entomologist spent six weeks at the Station early in 1935 in continuation of his researches on the eco-climates prevailing among coffee bushes.

The long-awaited Tanganyika sisal station came into being during the year. The site selected is at Mlingano on the Tanga-Muhesa main road, 20 miles from Tanga and 27 from Amani, and 2 miles from Ngomeni Railway Station. The area purchased is 440 hectares, the greater part of which is well suited to the purpose of field experiments.

The Management Committee of the Station, appointed by the Tanganyika Sisal Board, consists of a representative of the Department of Agriculture, the Director of the Amani Research Station, Mr. J. V. Gray, and Mr. H. Tanner. Mr. George Lock, District Agricultural Officer (Sisal) has charge of the Station.

Good progress has been made with the clearing of the estate from the Ceara rubber with which it was originally planted. A range of suitable planting material has already been transferred from Amani, including a collection of Agave species and varieties, and 17,600 suckers and 5,400 bulbils of *A. amaniensis*. The suckers were planted direct in the field and occupy an area of 16·3 acres. This will supply in due course information regarding the yield of this species under estate conditions, and will produce large quantities of planting material.

Sisal and other Agaves.

Breeding work with the fibre Agaves has continued actively during the year, and the study of its cytological basis has been pursued by the Geneticist. Light has been thrown from this source on certain incompatibilities exhibited in the interspecific crosses attempted.

The earliest seedlings of *A. sisalana* have reached maturity and their fibre is undergoing comparative examination. A further 9,000 seedlings have been planted out at Sigi. The first batch of *A. amaniensis* seedlings is still in the nursery, and a large supply of seed from this species, both self-pollinated and crossed with *A. angustifolia* and *A. sisalana* is nearing ripeness.

In the plot established at Sigi for comparison of the development of *A. amaniensis* and *A. sisalana*, now in its third year, the superiority of the former species is increasingly apparent. Material of *A. amaniensis* has been supplied to the Kenya Sisal Growers' Association for the planting of small trial plots over a wide range of Kenya estates.

A consignment of 5 cwt. of *amaniensis* fibre grown at Sigi was sent to Messrs. Hawkins & Tipson, Ltd., London, for spinning tests, and was made up into rope, box cord and twine. The results of the investigation were received through the Imperial Institute, whose Advisory Committee on Vegetable Fibres regarded them as very promising and considered that production might usefully be extended, as the material if well prepared should be readily saleable. The report was published locally and in the Imperial Institute Bulletin, Vol. 32, p. 540. A later crop, amounting to $9\frac{1}{2}$ cwt. of No. 1 grade, has been sent to British Ropes Ltd. for fine spinning tests.

Mechanical determination of the breaking strain of fibre from various sources proceeds continuously in the laboratory of the Physiologist, and a large quantity of data has been accumulated. The equipment for decortication has been increased by the acquisition of a raspador, and of an oil engine to supply power to this

and to the Cormorant decorticator presented to the Station last year. These facilities are required for the comparative examination of the large number of seedling types now beginning to mature. Whether the raising of seedlings should be transferred to the Sisal Station is a question of convenience which may be left for later consideration.

In connexion with proposals for grading, information has been supplied as to the proportion of fibres of different lengths existing in the leaf and as found in commercial samples of extracted fibre.

Coffee Investigations.

The orderly progress of work on breeding, recording of yields, and vegetative propagation is recorded in the report of the Geneticist. The results of past work on the selection of *robusta* strains are now represented by large nurseries of plants raised in preparation for field trials at Kwamkoro. Similar preparations have been made for the planting of *arabica* grafted on *robusta* stocks, while practically all the old *robusta* trees at Amani have been cut back and grafted with *arabica*.

The investigations of the Physiologist were interrupted by his absence on leave for two-thirds of the year. Additional evidence supports his observations regarding the association of the most frequent type of over-bearing and dieback—a subject to which continuous reference has been made in these reports—with depletion of carbohydrates. This theory has a direct bearing on questions of pruning, and it is believed that its application on one estate is leading to distinct improvement.

The work on coffee root systems, first concerned with the distribution of the feeding roots, has now developed into a study of the relation between the rate of absorption of water and its utilization by the plant, a subject of fundamental interest.

A paper on the "Climate and Eco-climates of Coffee Plantations," embodying the results of the Entomologist's studies during his first tour of service, will shortly be published through the Crown Agents. The subject has been further pursued, for comparison, in the Kilimanjaro area and has led, incidentally, to the discovery of a new and interesting parasite of Antestia, the biology of which is now being studied in detail. As the parasite has not so far been found in collections made for comparison in Kenya, its introduction might have results of considerable importance in the control of the most widely injurious of coffee pests.

The assembling and transmission of coffee bean samples for liquoring tests, sent through the Imperial Institute to Messrs. John Gilliat & Sons, have been continued. The reports are still incomplete, but those received show no evidence of correlation with price tendencies in general, or in particular cases, with the actual price realized for the consignment represented by the sample.

The Biochemist has made some further experiments on coffee prepared with and without fermentation and on heat treatment, the results of which are set out in his report. Similar investigations on a wider scale are now being made for the Kenya Coffee Board by Dr. E. Martin Case, who visited Amani during the year to discuss methods and results and to compare points of view.

Virus Diseases.

The intimate study of the nature of the transmission of a plant virus by an insect vector, as carried out over a long period with *Cicadulina mbila* and Streak disease of maize, appears to be reaching limits beyond which the utmost perseverance and ingenuity cannot make much further advance unless and until some new line of approach is discovered.

An increasing amount of attention is being given to the mosaic disease of cassava, the results of which reveal that the subject is much less simple than at first sight appeared, owing to the existence of several, probably many, distinct strains of the virus, the effects of which are further complicated by varietal differences in the host. Touch is being maintained with investigations in West Africa, and the range of cassava varieties available is being increased by importations from other tropical countries.

Vegetable Insecticides.

Further interesting results have been obtained in the study of the insecticidal value of local and introduced fish-poisons. Of many additional plants examined there is one, *Mundulea suberosa* Benth., a widely distributed small tree, the bark of which has distinct promise for commercial use. Collections from as wide a range as possible are being made and compared for toxicity.

Material from the small plots of *Derris elliptica* which have been growing at Amani for several years has recently shown a high rotenone content, in contrast to samples taken at an earlier stage. There would seem to be no reason why East Africa should not have its share in the rapidly developing trade in this commodity. Sold on rotenone content, which has been the standard adopted hitherto in the United States of America, the principal market, the Amani roots would have a high value.

The difficulty with all vegetable insecticides is that of standardization. It is now becoming generally recognized, for example, that the rotenone content of Derris may bear little relation to the toxicity as determined by biological tests. Pyrethrum, in respect of its recognizable compounds, is in somewhat similar cases. Mundulea bark, in some samples, approaches Derris in toxicity, yet contains only a fractional percentage of rotenone. Biological tests are themselves very difficult to standardize, but they are at any rate direct, and the problem of their perfection is deserving of much further study.

Systematic Botany.

The Botanist was on leave for two-thirds of the year. A considerable part of this period was spent in the study of East African plants in the principal botanical collections in England. The remaining time at Amani was largely occupied with the identification of plants used in native medicine, special opportunities for which were furnished by the material provided by two unofficial collectors, Messrs. P. R. Bally and H. Koritschoner. Contact has also been maintained in the same connexion with the Analytical Chemist attached to the Medical Department at Dar es Salaam.

Soil Conference.

In succession to the first conference of East African Agricultural and Soil Chemists held at Amani in 1932, a second conference met in Zanzibar in August, 1934. The object was to review the progress made in the intervening two years, to contribute information for an East African Soil Map, and to decide upon the methods of representation to be adopted.

Soil Chemists attended from Kenya, Tanganyika, Uganda, Zanzibar and the Amani Research Station. It was unfortunately not possible for the representatives of the Rhodesias and Nyasaland to accept the invitations issued to them. A report of the Conference has been issued from Nairobi by the Secretary to the Governors' Conference in the series " Technical Conferences of the East African Dependencies ".

The compilation of the soil map from the drafts presented, and its presentation to the International Congress of Soil Science, were delegated to Mr. G. Milne, who has since devoted a considerable part of his home leave to the work. While the information available is far from complete, even in broad outline, the issue of the map will serve the double purpose of recording what is known and calling the attention of potential observers to the uncharted spaces which remain.

Ornithology.

Mr. and Mrs. R. E. Moreau have been able to extend their studies of the geographical distribution of birds to the mountains of the Rift Valley in Tanganyika, the biology of which was practically unknown. Nearer home the Pare mountains have been worked over by collectors, while the Mkomasi Valley, which separates them from the West Usambaras, has been systematically visited and has provided a rich field for observation.

Bird stomachs from Mr. Moreau's collection, covering a wide range of species, have been subjected to biological analysis. Only the fringe of a subject of considerable scientific and practical interest has been touched, but the information gained is practically all new and interesting and often unexpected.

Visiting Workers.

Dr. H. Walter, Professor of Botany and Director of the Botanical Institute and Garden, Stuttgart, and Mrs. Walter were provided, with the sanction of the Secretary of State for the Colonies, with quarters and laboratory accommodation from August to December, 1934, for work on the water relations of tropical plants.

Dr. Harold Kirby and Mrs. Kirby of the University of California spent a few weeks at the Station during a widely extensive tour for the collection of the intestinal protozoa of termites.

Professor Baeyens of the University of Louvain paid a visit of some days for the discussion of questions relating to soil science before starting on a long exploratory journey through the Belgian Congo.

New Buildings.

The temporary building, erected some years before 1914 as an hotel, which has served to house the Secretary's offices, Post Office, stores, and guest rooms, reached the limits of its endurance and has been replaced during the year by a permanent structure in stone. The accommodation provided includes a laboratory and store for the Geneticist, who has previously occupied an annexe to the Pathology Laboratory. A new guest house has been built on another site.

A fourth insect-proof greenhouse was completed for virus research, and an earlier one, in a less convenient position, made over to the Geneticist. The large open verandah of the Physiology Laboratory was converted into a greenhouse for controlled experiments with coffee.

The Station workshops have been removed from their undesirable proximity to the Library and accommodated in a conveniently existing and adaptable iron shed.

Plantations.

The Amani Plantations have been maintained in good order and the plots of sisal seedlings and other Agaves much extended. The nurseries have been occupied to capacity with the raising of planting material of various economic crops for the purpose of large scale experiments.

These experiments will be carried out on the Kwamkoro Estate, where preparations have been made by the clearing of derelict coffee areas and the establishment of supplementary nurseries. The crops to be planted include selected lines of *robusta* coffee, *arabica* on *robusta* stocks; *Cinchona Ledgeriana* on its own roots and grafted on *succirubra*; *Aleurites montana* and *Derris elliptica*.

W. NOWELL,
Director.

REPORT OF THE PLANT PATHOLOGIST.

Virus Diseases of Plants.

(a) *The mechanism of the transmission of plant viruses by insects.*

During the past year work has continued upon the general lines stated in my previous reports. None of these lines has however been yet brought to a satisfactory conclusion, and my only publication during the year was a short note describing work mentioned in my last report.

The chief problem that has received attention has been the mechanism of the process of the inoculation of the maize streak-virus by *Cicadulina mbila*. It is well known that a number of plant viruses, including that of streak disease, while readily transferred by the appropriate insect, cannot be artificially transferred from plant to plant. In such instances, where an obligate relation appears to exist between the virus and the insect, it is generally believed that the insect's mouthparts are the channel and its saliva the vehicle of the inoculation. This belief has arisen doubtless in part because such a mechanism of inoculation is known to occur in the transmission of the malaria organism by the mosquito; or, perhaps with more cogency, because no likely alternative mechanism can be postulated. It is true that various workers have considered the possibility that the virus might be transferred to the plant in the insect's faeces or in regurgitated food-material. Both hypotheses however are disproved by the experimental evidence that has accumulated. A transfer of the virus in the saliva appears to be the only tenable hypothesis.

In my last report, I implied that this line of work constituted a side-issue to my main problem; and in undertaking it I anticipated no considerable difficulties in obtaining satisfactory proof of a mechanism in accordance with the general belief. In the event it has proved quite otherwise. It seems at present nearly impossible to reconcile my evidence with the conventional view of the function of the saliva in inoculation. And yet I can suggest no other mechanism whereby the virus can be transferred from the insect to the plant. In view of these results I believe that the time devoted to this problem is justified, even though a solution may prove to be unattainable.

I have obtained satisfactory proof that the stylets constitute the channel of the virus inoculation. I have also proved that they must penetrate to the phloem for the inoculation to be successful. These two conclusions are based upon direct experimental evidence; in order to obtain an understanding of the manner in which the virus passes from the stylets into the plant, only indirect experiments can be used. To the interpretation of a considerable body of such experiments I have applied the information concerning the manner of excretion of saliva obtained from the study of

living insects feeding upon a fluid through a membrane. The outcome has been to leave in doubt the function of the saliva in inoculation. Further experiments are in progress; but I anticipate that little more can be done with the technique now available. It will probably be advisable to place my data on record and to await the interpretation of them that future researches may bring.

During the course of this work evidence accumulated showing the extreme variability in inoculative ability of the insect material. All pure active *Cicadulina mbila*, as I have already shown, are capable of transmitting the streak virus if allowed prolonged contacts with diseased and healthy plants in succession; but, even though allowed equal opportunities for obtaining the virus, individual insects vary greatly in their ability to inoculate plants successfully during short contacts. Individuals also vary in their capacity to remain infective following a single contact with a source of the virus. By breeding and by experiment I am trying to discover the basis of this variability.

The difficulties in the breeding of *Cicadulina zeae* (which by a typographical error appeared as " feeding " in my last report) have not been entirely overcome. After many failures a normally fertile active line was raised; but this proved to be infertile when crossed with a pure inactive line. Microscopic examination has now revealed minute morphological differences between the two lines. It is possible therefore that the *Cicadulina zeae* with which I have been working is in reality a group of closely similar species. The course of future work will depend upon a decision on this question of specific rank. As regards my past work, while some of the failures in breeding may have been due to the attempt to cross different species, the majority cannot have been due to this cause, for a loss of fertility has been repeatedly encountered in inbred lines. On the whole, the evidence, although inconclusive in the absence of data from controlled crosses between pure lines, indicates that the manner of inheritance of activity in the species with which I have been working is similar to that in *Cicadulina mbila*.

The sampling of the natural *Cicadulina* population in two localities was continued on the lines mentioned in my last report. The later evidence obtained however led to no definite conclusions and the work has been discontinued. I have had no opportunity to continue the work upon the histology of *Cicadulina mbila* begun in 1933 at Cambridge.

(b) *Mosaic disease of Cassava.*

In accordance with the suggestion of the Agricultural Adviser to the Secretary of State that an attempt should be made to co-ordinate work upon this disease in West and East Africa, I have entered into correspondence with the Mycologist and Economic Botanist of the Gold Coast and the Mycologist of Sierra Leone. This correspondence has resulted in an exchange of information

concerning local conditions and programmes of work. This exchange will probably be useful to all concerned; but the evidence, obtained from tests near Amani of Gold Coast varieties, mentioned in the next paragraph, shows that the problems in East and West Africa are not identical. It must be recognized therefore that there is a limit to the usefulness that may be anticipated from co-ordination; independent investigation of the problem point by point will still be necessary in each region.

Through the services of Mr. H. A. Dade, Mycologist, Gold Coast Department of Agriculture, and the Director of the Imperial Mycological Institute, who undertook the forwarding of material by air mail, we have received four cassava varieties immune from or highly resistant to mosaic in their country of origin. Two only, Calabar and Sareso, have as yet been tested for resistance in East Africa. Both have proved to be highly susceptible, both by grafting and by natural infection in the field, and to be markedly more severely damaged by the disease than local varieties. The interpretation of the result is not certain; but at present I think the only likely one is that the strains of the mosaic virus differ in East and West Africa. If this be the true explanation, a most important principle is revealed. It will be necessary to observe caution in the application of results obtained in one region to the other. It also points a plain warning against the import of cassava planting material from outside countries without the most stringent quarantine precautions; a country in which mosaic is prevalent might regard the introduction of mosaic-diseased material from abroad as of little consequence; it is now obvious that a new virulent strain of the virus might be introduced with disastrous consequences.

In the hope that a difference in the symptoms of mosaic in East and West Africa might thereby be revealed, I have interchanged with Mr. Dade both photographs and preserved specimens of diseased leaves. No certain difference has been found. All the examples supplied by Mr. Dade could be matched by leaves collected in the field in the Amani district. It is unlikely that much progress can be made in the differentiation of strains of virus by symptom-comparison, except perhaps to a limited extent by growing together plants of one variety infected with the several strains.

It has become obvious that several strains, distinguishable by their symptoms under the controlled conditions stated above, exist in the Amani district. A collection is being brought together in an insect-proof greenhouse, all possible strains being transferred to plants of a single variety by grafting. It would be useful to add to this collection examples of the West Coast strains, but at present the risk involved can hardly be justified.

The recent demonstration by a number of workers that certain mild strains of viruses affecting solanaceous plants may confer immunity from severe strains of these viruses has opened up possibilities of an important new line of disease control. If this principle could be applied to a vegetatively propagated plant such as

cassava, a particularly advantageous method of control would become available. I have carried out experiments to test this possibility. While the work is as yet uncompleted, it may be said that results have been disappointing. It appears that my hopes of a solution to the mosaic problem along these lines are unlikely to be fulfilled.

The observations of workers in West Africa have shown that a number of the " indigenous " cassava varieties are there highly resistant to the mosaic virus. At one time I hoped that the same might be true of East Africa, and that control of the disease might be obtained by the use of resistant varieties. I now think the prospects of such control to be unfavourable. As I have already noted, certain of the resistant West Coast varieties fail when transferred to the East. Of a large collection of " indigenous " varieties brought together at Morogoro by the Tanganyika Department of Agriculture (to officers of which I am indebted for the data), none survived the mosaic-infection. I visited Morogoro in September, 1934, in order to discuss with officers of the Department the possibilities of breeding resistant varieties. So long as the only plants available as parents are themselves susceptible, the prospects of success in breeding a resistant plant appear to be slight. In spite of the disappointing results obtained hitherto, the introduction under quarantine precautions of varieties from overseas should be continued, in the hope that some may be found resistant to the local strains of mosaic. In accordance with this policy, consignments from Jamaica and Trinidad are now undergoing quarantine at Amani, and further consignments are expected from elsewhere.

Meanwhile a collection of the local varieties has been made at Amani, and although none offers any promise of considerable resistance, they have been distributed to Zanzibar and Uganda for trial.

In the event of both the preceding lines of work failing, the only measure for control that can be recommended at present is the well-known one of the selection of disease-free planting material. There is little doubt that this measure would lead to a considerable increase in yield even where extensive secondary spread of the disease occurs. In many regions, however, the selection of disease-free plants is now nearly impossible. On the other hand at the higher elevations around Amani, and probably elsewhere in mountains, secondary spread is slight, and disease-free crops can be raised without difficulty. It may well be that in time the transfer of planting material from the hills to the plains may become a regular practice. On somewhat similar lines an experiment has been arranged with the Department of Agriculture, Zanzibar, whereby a stock of healthy planting material will be supplied from Amani and will be grown in Zanzibar on an isolated site. If by this means it is found possible to maintain a healthy stock, an organization for the issue of healthy planting material to growers may result.

I have carried out a number of experiments to study the rate of movement of the mosaic virus down the stem of the cassava plant following secondary infection. Results showed that within one month of the appearance of symptoms the virus had invariably passed down to the base of the stem; on the other hand it usually failed to pass up into side branches from this stem, or into other stems arising from the same original sett. The intention of these experiments was to determine whether in practice some measure of control could be attained by cutting off the tops of plants as soon as symptoms appeared, or by using only the bottom parts of stems as planting-material; it is clear that both practices are useless.

The field experiment now in progress at Kiwanda (thanks to the valuable co-operation of the Mission authorities) has demonstrated clearly the very great influence of season upon the rate of mosaic infection.

In September, 1934, I visited Zanzibar for the purpose of discussing with the Department of Agriculture possible investigations of the cassava mosaic disease. This visit has resulted in a scheme for co-operation with the officers concerned with this problem. I found the conditions in Zanzibar to be closely similar to those ruling in the coastal area near Tanga, and it is likely that results obtained at Amani will be directly applicable to Zanzibar.

(c) General.

I have again to place on record the valuable work carried out by my assistant, Mr. R. F. W. Nichols.

H. H. STOREY,
Plant Pathologist.

REPORT OF THE ENTOMOLOGIST.

I returned from leave on the 19th of October, 1934. While in England a number of Research Stations were visited for the purpose of consulting with various specialists, and I also attended the Third Imperial Mycological Conference held in London during September.

The study of climate in relation to insect pests of coffee continues to occupy the greater part of my attention. At present however there is little that can usefully be added to a paper* which is now in the press.

One of the main difficulties is that of estimating with any approach to accuracy the insect population of a locality with a given

* "Studies on the Ecology of Coffee Plantations in East Africa. I. The Climate and Eco-climates of Coffee Plantations."

eco-climate. This cannot be done at all without destroying at least a proportion of the population, and when, as often, the locality is of small extent such destruction will vitiate any subsequent census.

The observation of the effect of different eco-climates on the life-cycle of an insect also presents great difficulties. Even when sedentary insects or immobile stages are chosen for observation, the natural wastage is in most cases so great that a dishearteningly large number of experiments have to be started for one that arrives at fruition.

Much more information is required on the effects of weather (as distinct from climate) on insects, and attempts will be made to obtain this during the coming year.

During January and February, 1935, some six weeks were spent at the new Coffee Experimental Station at Lyamungu, near Moshi. As there is as yet no established coffee on the station most of the work had to be performed on neighbouring plantations, which proved unsatisfactory in many ways.

One of the objects of this visit was to determine whether the relation between the standard climate and the eco-climate of coffee bushes, as ascertained in Kenya, hold good for a district with a somewhat different standard climate. So far as the observations made have as yet been studied, it appears that it does.

On the entomological side, two discoveries of some interest may be mentioned here.

The Coffee Leaf-miner (*Leucoptera*) was found to be prevalent in two localities near Lyamungu which, though only a few hundred yards apart, were subject to widely different eco-climates. Closer examination revealed the fact that two distinct species were concerned. In a cool, damp, sheltered and heavily-shaded locality, there was present only a species which lays its eggs in neat rows close to the vein of a leaf. In a warmer, drier, exposed and unshaded situation, almost all the miners were a species which lays its eggs singly or in small groups scattered on the lamina. In some situations, such as the outside leaves of partly shaded bushes, or the inside leaves of unshaded ones, the two species were found together. It has been subsequently learnt that Mr. Ritchie, Government Entomologist of Tanganyika Territory, had previously determined by breeding experiments the existence of two species of *Leucoptera* on coffee.

It is also reasonably certain that the occurrence of two distinct species with different ecological preferences accounts for the divergent views that have been expressed about what was considered to be the one species *L. coffeella* Guér. For instance Trench, in Kenya, wrote that " Leaf-miner occurs on every plantation in the Colony. Only one severe outbreak was noticed. . . . The coffee was very heavily shaded and sheltered from the wind." (Rept. Agr. Dept. Kenya, 1928, p. 266), whereas Ritchie, in Tanganyika, stated (Tanganyika Territory Department of Agriculture, Ann.

Rept. 1931, p. 83) that " The worst incidence of miner observed has been in districts of high prevailing winds."

It has been found that the Coffee Bug, *Antestia Lineaticollis*, Stol, is extensively parasitized by a species of *Strepsistera*, probably belonging to a hitherto unknown family. It is believed that apart from a single instance recorded by Sharp (*Camb. Nat. History*, Vol. 6, p. 303, 1901) this is the first case of a Heteropterous insect being " stylopized."

In the Kilimanjaro district, this parasite was found in over 50 per cent. of the *Antestia* examined. It also occurs in the Arusha coffee plantations, but from collections of *Antestia* kindly forwarded to me by various correspondents, it seems to be absent from the West and East Usambaras and from Kenya—at least from the districts of Kiambu and Limuru.

Although this parasite causes but little premature mortality, except possibly among young nymphs, yet it renders the female certainly and the male probably entirely sterile. Its biology is now being worked out as completely as possible; it appears to present features of great interest even for such an anomalous order of insects as the *Strepsistera*.

Present indications are that it can be easily bred in captivity, and while it is unlikely that a parasite of this nature could ever effect complete control it may well prove to be a valuable means of reducing the rate of increase of *Antestia* during the intervals between spraying measures. There is evidence that the active first-stage larva of the Strepsisteron is able to emerge alive in large numbers from *Antestia* that have been poisoned with arsenic, and it is tentatively suggested that its presence may be at least one of the reasons why arsenic bait spray is so much more consistently efficacious in the Moshi and Arusha districts than in Kenya.

T. W. KIRKPATRICK,
Entomologist.

REPORT OF THE SOIL CHEMIST.

General Soil Survey and Classification.

In my report last year I gave a summary of the progress that had been made up to April, 1934, in studying the distribution of soil types in East Africa. A great deal of country still remained for which no information was available, but a decision had been taken to proceed with the compilation of a map, with the double purpose of putting the records into a form in which they could be conveniently reviewed and used by everyone interested, and of directing attention to the large field that is still untouched.

This project took definite shape later on in 1934 as the result of a Conference (which will be referred to again below) held at

Zanzibar in August; and I am now (in April, 1935) able to report that a soil map of four of the territories that this Station serves has been drafted, and requires only the further few weeks' work of fair drawing before being ready for publication.

This map is the outcome of some years of co-operation between Amani and the interested persons and departments of government in Tanganyika, Kenya, Uganda and Zanzibar, and I should like here to make a general acknowledgment to all who have, in various ways, contributed the records that are incorporated in it. The Agricultural Chemists of the three last-named dependencies drafted the portions covering their own territories and sent them to Amani in November last. Since then I have continued the work of co-ordination, and the compilation of the Tanganyika map, in England during leave, and am indebted to the Royal Geographical Society for facilities they have afforded me for doing this in their house in London.

With the resources of a unique geographical library at my disposal I have spent much time in trying to recover, from the published writings of many travellers in East Africa, such notes on soils as they have put on record, particularly for the regions for which my files were otherwise empty. The results, while not negligible, have been disappointing. It is unfortunate, that *Soil* has only lately begun to be admitted, in public opinion, to a place amongst the natural phenomena worthy of careful note in the exploration and administration of a new country, and it has been a rare thing even for observers of sound scientific instinct and training to record so much as the colour of the soil over which they travelled, complain of it though they might in the form of mud or dust. The old painstaking observational journeys on foot, which with an informed viewpoint in this sense might have been so fruitful, are now no longer a feature of travel in East Africa. Nevertheless there must be persons now or lately resident in the areas that appear as blanks in the map I have just compiled, who know the simple field properties of soils which I have been unable to find recorded, and who will be stimulated by its publication to come forward and communicate their observations.

Three short papers descriptive of the map and its principles and significance in various aspects have been prepared and accepted for publication in the proceedings of the Second International Congress of Soil Science, which is to be held at Oxford in August, 1935, and to which the map will be presented as of general interest to workers in soil genetics, classification and cartography. The titles of the papers are :—

A Provisional Soil Map of East Africa (Kenya, Uganda, Tanganyika and Zanzibar).

A Short Geographical Account of the Soils of East Africa.

Composite Units for the Mapping of Complex Soil Associations.

The first two of these incorporate material contributed by my collaborators in the compilation of the map (Messrs. Beckley and Gethin Jones for Kenya, Martin and Griffith for Uganda, and Raymond for Zanzibar) and are to appear under our joint names. A fuller Memoir, expanding these papers and including acknowledgments of all sources of the information, is in preparation for publication simultaneously with the map. I cannot omit here, however, to refer to two of my sources for the Tanganyika section, without which it would have been greatly more incomplete than it is: namely, the full daily notes on his many reconnaissance journeys between 1925 and 1934 which Mr. C. Gillman, Chief Engineer of the Tanganyika Railways, has placed at my disposal, and the soil notes and maps made by Dr. E. O. Teale and his colleagues of the Geological Survey for routes in the Iringa Province and the country between Kigoma and Biharamulo.

It will be understood that in attempting to represent an area of nearly 700,000 square miles on a map measuring about 28 by 34 inches, not much detail can be shown for any given locality. The soil types have been classified into ten major groups of which five are further subdivided, and a notation has been devised for showing when two or more of these groups are associated together in any one district. The grouping corresponds to differences of origin and morphology. That is to say, it is an attempt at a natural classification akin to those in use for the plant and animal kingdoms, and does not purport to give a picture directly interpretable in terms of fertility, any more than mention of the order Gramineae connotes the economic value of particular grasses or cereals. Too much should not be expected of the map, therefore, as an instrument of immediate guidance to agricultural and pastoral industry. It is but a first step, showing on broad lines the kind of material that presents itself for further study and sub-classification in each area. It needs to be followed up by organized field survey in more detail wherever a closer assessment of soil conditions is required.

In preparation for the drafting of the map I drew up two papers for circulation in advance to the members of the Zanzibar Conference. These were:

> Some Suggested Units of Classification and Mapping, particularly for East African Soils.
>
> The Extent to which Volcanic Rocks give rise to Distinctive Soils, examined from East African Occurrences.

Of these the first is now in the press for publication by the International Society of Soil Science in *Soil Research*, and the second is being revised for publication so as to incorporate data since to hand. Abstracts of both are included in the published Report of the Zanzibar meeting.

The visit to Zanzibar gave further opportunity of working out the soil types of that island, with the aid of the collection of profiles that Mr. Raymond has established there since my last

year's visit. For such a comparatively small area, the range of problems in soil genetics in Zanzibar is a wide one, and some of the hypotheses put forward tentatively in my " Sketch " of January, 1934, are already shown by Mr. Raymond's new data to have been over-simplified. This is especially true of the sandy areas occupied mainly by coconut and food-crop cultivations, where an unsuspected variety of profiles and parent materials has been brought to light. Under the present conditions of utilization of these sandy lands such complexities of soil type are perhaps not worth sorting out, but they illustrate what I think is a general truth, namely that soil classification and mapping is apt to be a more intricate matter on sedimentary formations than on igneous and metamorphic rocks, and facile generalization is accordingly more dangerous. The coast belt of the East African mainland, and a great inland region as well in the Eastern and Lindi Provinces in Tanganyika, are covered by sedimentary rocks, and I do not think much of value in assisting their agricultural development will come from " extensive " or " reconnaissance " soil studies, unless these are supplemented by the fairly intensive examination of sample areas. The regions in question mostly appear blank on the soil map at present; the only exception is the neighbourhood of Tanga, where local travelling from Amani and the search for suitable ground for a sisal experiment station have afforded some clues towards understanding a very difficult distribution of soil types. It is perhaps significant that the sisal station has, after all, been founded within the boundary of the basement metamorphic rocks, where soil uniformity is mainly a question of surface relief. In the sedimentary belt just to the east, with its rapid succession of outcrops of lithologically differing parent materials, an additional disturbing factor enters, and a sufficiently large block of uniform ground would have been harder to find.

Following the Zanzibar visit a short excursion was made in company with the Director, under Mr. Gillman's guidance, to examine the soil sections exposed on the Central Railway between Soga and Dar es Salaam. This again brought strongly to notice the dependence of soil characters as now found upon the nature of the detrital materials assembled in Tertiary and later times by the sedimentary processes.

Advantage was taken in November of the visit of a British Museum ecological expedition to the high mountain regions of Uganda, to make arrangements for the collection of soil notes and profile samples in the rain-forest and alpine zones on the Mufumbiro group and on Ruwenzori. I am indebted to the authorities of the Museum, the leaders of the expedition, and Mr. P. M. Synge, for their promised assistance. Any records so obtained should contribute much towards understanding the processes of soil formation under *cool* tropical conditions.

During the year accessions of material for the permanent exhibit of East African soil profiles have been received from Kenya (through

Messrs. Beckley and Gethin Jones), from Northern Rhodesia (through Mr. C. G. Trapnell, Ecologist, Mazabuka, and Mr. U. J. Moffat, Agricultural Officer, Abercorn), and from Tanganyika, particularly the neighbourhood of Mamboya in the Kilosa district (through Mr. N. R. Fuggles-Couchman, Agricultural Officer). The Northern Rhodesian material shows that the classification that has been provisionally adopted for Tanganyika soils can with some confidence be extended to include soils further south. My assistant, Mr. Calton, has spent much of his time this year in building up laboratory information on the soil types represented in the collection, more especially by numerous analyses of separated clay fractions.

Irrigation Problems.

In my annual report for 1932-33 reference was made to a chemical survey of the streams arising on Mount Meru in Tanganyika, many of which are used for irrigation. The results were published in 1932. An opportunity of extending this work to the waters of Kilimanjaro occurred this year, on the appointment by Government of a Commission to survey the water-supply problems of both these districts. The members of the Commission (Dr. Teale and Mr. Gillman) kindly undertook, with the co-operation of the officers of the Department of Agriculture in Moshi, the collection of water samples from all the Kilimanjaro streams visited during the survey. The chemical work has since been done by Mr. Calton in the Amani laboratory, and the results await working up on my return from leave.

A number of soil profiles from an area lying along the upper Pangani River between Kahe and Same, which is proposed to be brought under irrigation and settled by native cultivators, have been examined at the Department of Agriculture's request for alkalinity and salt-content, along with samples of the water to be used. Mr. Calton, who did the analytical work during January and February, has reported provisionally on his results. They indicate the existence of a risk of " alkali " troubles on this land. I am arranging for discussion of these analytical results with the chemists at the Rothamsted Experimental Station who handled the soils from the Sind Irrigation Scheme in India, as the two undertakings, though vastly different in scale, probably have technical points in common.

Miscellaneous.

It has been mentioned above that soils were examined in connexion with the sisal experiment station proposed to be established near Tanga. The work consisted of a fairly detailed survey of Mlingano Estate (comprising some 440 hectares under abandoned Ceara rubber) and reconnaissance visits to several other sisal estates. About ten days were spent on this in the field in June, 1934, in company with Mr. J. C. Eyre, Agricultural Officer at

Tanga. A report was submitted advising that conditions were suitable at Mlingano if the problem of water-supply could be solved, and recommending a survey by air-photography as the best means of estimating the proportions of well- and ill-drained land on the estate before clearing.

At the Zanzibar Conference I had hoped to meet the representatives of Nyasaland and the Rhodesias, and so to make progress in the linking of my work with theirs beyond the point that can be reached by correspondence. They were not, however, able to be present, and the desired co-operation between the northern and the southern group of East African dependencies, in such matters as soil classification and mapping, erosion control, green manuring and maintenance of fertility under intensified native production, still, after the second conference summoned for the purpose, remained undiscussed. In regard to Northern Rhodesia, however, I have since had the advantage of full discussions with Mr. Trapnell (Ecologist) in England, following his visit to Amani in November last, when he was able to spend some time in comparing material gathered during his own surveys with that available for study at Amani.

Following the Zanzibar Conference I drafted its Report, which is being published under the auspices of the Governors' Conference, Nairobi. It includes abstracts of all the papers presented and full reports of the discussions.

In September several days were spent at the laboratory by Professor J. Baeyens, head of the Pedological Institute of the University of Louvain, Belgium, before he proceeded on a mission of soil investigation into the Belgian Congo.

Mr. H. B. Stent, Soil Chemist to the Coffee Research Station, Lyamungu, Moshi, continued to work at Amani throughout the year under review, pending the completion of his new laboratory.

I took part in a co-operative investigation of methods for the determination of organic carbon in soils, in which nine standard samples representing diverse types of soil were circulated from Rothamsted to a number of laboratories in Europe and America. Mr. Calton completed this work after I left Amani on leave, and I reported on our results in January. A number of check determinations of soil acidity were done in June, 1934, for the Zanzibar laboratory.

G. MILNE,

Soil Chemist.

REPORT OF THE BIOCHEMIST.

Insecticides.

During the year a considerable number of plants were examined for toxicity to insects. My usual basis for considering a plant as a possible source of insecticides is a report that the natives use it as a fish poison, and it is astonishing how very many plants are claimed to be effective as such.

Many of the plants recently examined have been suggested to me and collected by Mr. P. R. O. Bally, who is employed by a well-known firm of Swiss pharmaceutical manufacturers to collect plants likely to contain useful drugs. In the course of his collecting he comes across many reputed fish poisons, and many of these I have received from him and tested.

All tests are first carried out biologically, i.e., by determining the toxicity, if any, to insects. Only when hopeful biological results are obtained is any chemical investigation undertaken.

As regards *Tephrosia vogelii*, which I have previously reported as making an efficient insecticide (vide *Annals of Applied Biology*, XXI, 649, 1934), the variety common around Amani and the coast is a white flowered one, whereas previous workers on this plant as an insecticide have used a blue flowered variety. This blue variety occurs to a limited extent near Lushoto and seeds were obtained and sown in Amani. I have recently examined the resulting plants and find a definite but slight difference in toxicity between the two varieties: actually the seeds of the blue variety are slightly more toxic, the leaves slightly less so, than those of the white variety.

Interesting results have been obtained from a small plot of *Derris elliptica* grown at Amani. These plants have been trained on supports instead of being allowed to lie on the ground as appears to be the practice in Malaya and possibly this may account for the comparatively high yield of both root-material and rotenone.

The fine roots contain 9·41 per cent. rotenone on dry weight and the coarse roots 7·49 per cent. The latter figure is of interest since it is often stated that only the fine roots are of commercial value.

The plants in question were $3\frac{1}{2}$ years old and one year previously when they were tested the yield of rotenone was only 5·40 per cent.: the ether extract was, however, the same (19·5 per cent.), as the present plants. I have compared the toxicity of these two samples and find them to be almost identical.

It is becoming clear from results obtained in many parts of the world that the toxicity of Derris root cannot be assessed solely by its rotenone content, and until a more characteristic chemical method is devised a biological test is undoubtedly the only reliable one.

Of new plants examined one, *Mundulea suberosa* Benth., is undoubtedly the most toxic of all indigenous plants so far examined. Work is not complete on it yet but I am satisfied that the bark is almost as toxic to various insects as the roots of *Derris elliptica*. It has been known for many years as a fish poison and as containing rotenone, but no work appears to have been done on it as an insecticide.

As the bark contains only 0·8 to 0·9 per cent. rotenone it is probable that some other toxic principle occurs in it, but so far I have been unable to isolate any.

Coffee.

Small scale experiments have continued on various methods of curing coffee, both as regards removing the mucilaginous matter and the temperature, etc., of drying.

It is clear that fermentation is quite unnecessary for removing the mucilage and that any suitable form of scouring the berries by friction will clean them at least as efficiently. Indeed, in some laboratory experiments the end result was not appreciably affected when the mucilage was not removed at all. Three samples of the same coffee berries were treated as follows: (1) was pulped and dried direct at 35° C., (2) was dried in the cherry at 35° C. and (3) was pulped, fermented, washed and dried at 35° C., in the usual way.

The three samples were forwarded to London and the report stated that the acidity was " fair to good " in each case and the body " very fair " for the first two and " fair " for the third. The fermented coffee was thus slightly inferior to the other two.

Although fermentation is not an essential process it is possible that it may have some beneficial effect on the appearance or taste of the finished product. Dr. Case, of the Kenya Coffee Board, considers that it does have some such slight effect but so far my results do not confirm this. The chief trouble in all work on coffee is the real lack of any standard method of assessing the results: when one has to rely on two such indefinite factors as taste and appearance, the estimation of which will obviously vary, especially taste, with even the same taster on different days, it becomes apparent that small differences in samples cannot be considered significant.

Experiments are being carried out, at such times as the coffee is in fruit, on the germinating power of the berry during the various stages of its curing, and on the effect of heat on this. I obtained some interesting results on the Kwamkoro coffee. Taken at various stages of curing, the germination percentages were as follows:—

After pulping	82
After fermentation	96
After one day's sun-drying	90
Finished in the hot-air drier	90

A series of similar experiments with the seed heated to various temperatures for different periods was spoilt by a very heavy growth of mould. Further work must now wait over until the next coffee season.

A series of samples of finished coffee subsequently heated for two hours at 45°, 55°, 65°, 75° and 85° C. respectively was sent to London for evaluation and they were all reported as practically identical, so that no conclusions can be drawn on this subject at present.

Acidity and Root Growth in Coffea Arabica.

This experiment was continued by me during the absence on leave of the Plant Physiologist.

Small coffee plants were grown in culture solutions of different pH and concentration in glass containers, and an arrangement for keeping the water aerated was fitted up.

The initial results were in agreement with the theory that coffee requires a neutral or only slightly acid soil; those plants in the more alkaline solutions producing quantities of fine roots whilst those in the more acid produced one long root with very few fine ones.

As the experiment continued, however, quite opposite results were obtained, the more acid solutions producing the better plants both as regards roots and leaves: and some of the plants in the neutral solution actually dying.

It must be emphasized that this was only a preliminary trial to test out the various experimental factors involved, and it is clear that the glass vessels were too small and most, if not all, the solutions too strong. In addition no greenhouse was available at the time so the plants had to be grown under a considerable amount of shade and artificially illuminated.

When suitable vessels can be obtained it is proposed to repeat this experiment on a larger scale.

Essential Oils.

No new oils have been discovered during the year.

I am carrying out an interesting experiment with a plot of about an acre of lemon grass: the grass grows rapidly and can be cut once a month throughout the year. The yield of oil and its citral content varies from month to month and so far I have been unable to correlate this with the weather conditions. This work is being continued.

Very good reports have been received from London of the Ylang Ylang oil distilled from the small pre-War plantation of this tree (*Cananga odorata*), at Sigi. It would appear to be well worth cultivating. Trees, probably from the same source, are growing in several places near the coast around Tanga, but so far I have been unable to obtain sufficient flowers from them to compare their oil with that from Sigi.

A small plot of *Aframomum amaniense* has been planted out as the oil from this plant has also been reported on favourably.

Other Work.

As usual a certain amount of analytical work and tests not coming under any of the main headings of my work have been undertaken during the year.

R. R. WORSLEY,
Biochemist.

REPORT OF THE PLANT PHYSIOLOGIST.

I have been absent on vacation leave for eight months out of the twelve under review. During this time the routine collection of crop records was supervised by the Geneticist, while water culture work has been under the charge of the Biochemist.

Coffee Investigations.

Owing to a combination of unsuitable conditions the water-culture experiments designed to determine the effect of various combinations of acidity and concentration on coffee roots have given inconclusive results. When suitable containers can be obtained the experiment will be repeated in a modified form.

Experience gained in the last year or so has shown that quantitative results can be obtained from the study of coffee roots when growing in glass-fronted boxes of special design. An experiment has been set up, using Amani soil adjusted to various reactions, with and without the addition of organic manures. The root growth of *C. arabica* will be followed by this method for two or three years.

A field technique for the determination of starch content of plant tissues has been developed. It is capable of giving results of reasonable accuracy, and will be of use in projected field studies on the relation between " dieback " and starch reserves.

Crop records for one complete year are now available from the artificial shade experiment on Lion Hill. The results so far are clear-cut, but it will be necessary to obtain records for at least one more year before any conclusion can be drawn, since with such a plant as coffee the crop in any particular year often appears to be correlated with that borne twelve months before. During the year the heaviest shade has been removed, and placed 12 inches from the ground. The effect on the trees is being carefully noted. It is a matter of interest that some of the trees have overborne during my absence. Analysis has confirmed starch depletion, root dieback has taken place as in the Arusha area, while an examination of the crops carried by these trees has shown that without exception they have borne heavily. The leaf symptoms, however, differ markedly from those seen in other districts. The typical " Arusha yellowing " has been much modified by Usambara conditions and by shade.

Almost the whole of my time since I returned from leave has been spent in a laboratory study of the water relations of coffee, in particular the relation between the rate of water uptake by the root system and the rate of utilization by the above-ground parts of the plant. The " active " root absorption of the coffee plant is very low, and the rate of supply of water to the leaves is almost entirely conditioned by the negative pressures in the xylem cells to which transpiration gives rise. It is a question of some interest whether the relation between the rate of uptake of water by the

roots and the negative pressure causing it is linear over a given range. The indications at present are that it is not, and that transpiration is affected by the negative pressure to which it gives rise. Full results are not yet available.

The only travelling I have done has been a short visit to the Arusha area for the purpose of collecting root material. Observations made there this year tend to confirm my opinion that dieback is caused by depletion of carbohydrates by the crop. One planter has gone so far as to evolve a system of pruning which aims at the increase of leaf area in relation to crop level. So far as can be seen at present it appears likely to achieve its main object, since starch reserves in such trees are higher than in those pruned normally. It is becoming increasingly apparent that one of the main cultural problems in coffee-growing is the maintenance of a correct balance between leaf and crop.

Sisal Investigations.

During my absence on leave I was able to visit a number of rope and twine makers. The experience thus gained will be of use in designing further testing methods for fibres.

Determinations of certain physical characters of sisal for the Geneticist have continued, and fibre characters can now be considered when making selections. Facilities for the decortication of single leaves will soon be available at Amani, and these will afford opportunity for further work.

F. J. NUTMAN,
Plant Physiologist.

REPORT OF THE GENETICIST.

Coffee.

General.—The health and vitality of *C. arabica* plots on manured land has been maintained at a high level. Plants on unmanured land are still, with few exceptions, indifferent.

Diseases and Pests.—Pests noted during the year include leaf miner, *Antestia*, and white stem borer. The two first mentioned occurred in fairly heavy infestations (*Antestia* for the first time in our experience) and the last mentioned in about the usual number.

Hemileia was noted on all *arabica* selections, on manured and unmanured plots, and also on grafted plants in varying degrees of intensity.

C. robusta has remained comparatively free from pests and diseases; *Xyleborus* was noted on a few trees only this season. A marked yellowing of the leaf followed by a considerable leaf fall occurred on most *robusta* plots. This may have been connected

with the unusually dry conditions which prevailed for a time as with an increased precipitation all trees have resumed their normal appearance.

Yields.—The average yields from trees of *C. arabica* have remained low and extremely variable from tree to tree. *Robusta* yields have maintained their high level with the exception of Quillou. The falling off in yield of this variety is in all probability due to the very heavy pruning carried out last season in combatting *Xyleborus* attack, most marked on this variety.

The proportions of the total season's crop harvested in each month of the year are similar for all *C. arabica* selections. In 1932 and 1933 a single peak period occurred, October in 1932 and July in 1933. During 1934 two definite peak periods occur; a minor peak in July and the main peak in November. A similar distribution is expected in 1935 as a heavy flowering in early December was followed by another heavy flowering at the end of February on all selections.

A closely similar periodicity is noted in the harvest figures of the crop from *C. arabica* scions on *C. robusta* and *C. liberica* stocks. The peak period for most varieties of *robusta* occurs in December-January and for *liberica* types in February-March.

Study of the yield records for individual plants over a period of five years suggests that local variation in external conditions is responsible for a great deal of plant to plant variation. Owing to the irregular stand of trees on most plots an adequate analysis of yield data is difficult.

Yield of grafts.—Yield records for the first crop from *C. arabica* scions, inarched in the seedling stage, on *robusta* and *liberica* stocks show wide fluctuations about a mean of 750 gms. of cherry per tree. The range in yield is from zero to 2,520 gms. No significant difference in yield is noted between the grafts on the various varieties of *robusta* used as stock or between these and the plants on *liberica* stocks. Six grafts of *arabica* on *liberica*, shield grafted in February, 1932, on yearling stocks, have given an average yield of 6·25 kilogrammes of cherry per tree for their second crop. The first crop was light and not recorded. The size of bean, quality and vegetative characters of the scion do not appear to be affected by the stock.

Bean.—Bean samples collected from individual trees during the past season show wider fluctuations than have been found previously. This variation has been particularly outstanding among selected trees of *C. robusta*, a continuous falling off in size being noted in the bean from most of these as the crop season progressed.

Vegetative propagation.—Attempts to root hardwood cuttings of selected *arabica* trees have been unsuccessful. A number of grafted plants of these parent trees have been obtained by inarching on *liberica* stocks.

Layering of *robusta* stocks has resulted in root development from the main stem and very few roots from the base of suckers. A few such shoots have been successfully transferred to the field with a hammer shaped rooting portion of the main stem at their bases. The attempts to root *arabica* shoots by layering have failed.

Breeding.—The few surviving trees of inbred selections of *C. arabica* have responded well to intensive manuring and some have flowered for the first time during the December rains. The parent plants have been self-pollinated again and the resulting seedlings will be transferred to the Coffee Research and Experimental Station, Moshi, in due course.

The crosses between varieties of *C. arabica* mentioned in the Annual Report for 1933-1934* have been harvested. Germination was poor owing to *Antestia* damage. The seedlings from these crosses have already been transferred to Moshi.

Interspecific hybrids.—One family (CB 10) of an interspecific cross *C. arabica* X *C. robusta*, previously reported to be sterile, produced six fruits, all pea berry, from which one seed has been germinated. Further heavy flowerings show a few more fruits set on open pollination. The proportion of fruits set to flowers is extremely low. The interspecific hybrids show a similar flowering periodicity to *C. robusta* which differs from that of *C. arabica*. Other interspecific crosses have failed to produce fruits.

Tests of inter-compatibility between a few selected *robusta* plants have been carried out but the results are not yet available. Further attempts at self-pollination of selected *robusta* parents were a complete failure. All experience goes to show that *robusta* is self-sterile.

Liquoring.—Sixty-eight samples of coffee from Kenya and Tanganyika have been forwarded for liquoring tests. The results of most of these tests have not yet been received. There has been a much wider response to the appeal for samples this year but once again there is a lack of continuity in sending samples from representative estates.

An analysis of coffee prices quoted in market reports shows an appreciable difference in average market value in favour of Kenya Coffee. Among the Tanganyika coffees those from the south-western Highlands and West Usambaras have been outstanding. A similar trend of superiority is not however discernible in the results so far obtained from liquoring tests. In a few cases, where direct comparison can be made between liquoring tests and the price realized for the consignment from which the sample was taken, the price obtained tends to be in inverse proportion to the liquoring score.

---

* Colonial No. 100.

Sisal.

Breeding.—Some 9,000 seedling plants of *A. sisalana*, grown from seed received in 1933 from Mr. J. McCrae, Longonot, Kenya, have been planted at Sigi.

A few samples of leaf from the most promising plants of the first batch of seedlings raised have been decorticated by hand. Two plants show a very satisfactory outturn of fibre. Comparative decortication tests still await erection of the decorticator.

The average rate of leaf production of seedlings of *A. sisalana* grown in Amani is considerably lower than that of plants grown from bulbil and sucker material.

Seedling plants have been raised of *A. Sartorii* and *A. amaniensis*. The young seedlings of the latter species already show a certain amount of variation. Some plants have small, white cartilaginous teeth on the leaf margin while others are, so far, smooth.

Development in the field of seedlings of other species has been satisfactory. Seedlings of *A. americana* show a general resemblance to type but, in detail, considerable variation in leaf shape, terminal thorn and the form and distribution of lateral spines. A similar detail variation with a general resemblance to parental type is recorded for seedlings of *A. ingens* var. *picta* and *A. angustifolia*.

Plants of the hybrid *A. angustifolia* X *A. sisalana* have made vigorous growth. The average rate of leaf production is about the same as that for plants of *A. sisalana* of the same age grown from bulbils. A few plants in this family are outstandingly good and will be ready shortly for fibre tests. All however bear spines on the leaf margin.

Plants of the cross *A. angustifolia* X *A. ingens* var. *picta* and the reciprocal have made good progress. Both crosses bear a strong resemblance to *A. ingens* (type) but show considerable detail variation.

The following crosses have been made during the year. The first three have produced fruits which are not yet mature. The last mentioned cross proved a complete failure, no fruits resulting from 1,300 pollinations.

(1) *A. angustifolia* var. X *A. amaniensis*.

(2) *A. amaniensis* X *A. angustifolia* var.

(3) *A. amaniensis* X *A. sisalana*.

(4) *A. amaniensis* X *A. cantala*.

Cytology.—Most of the cytological observations have been made on root tip material. Pollen mother cell divisions have been observed where flower material was available.

The results of these observations are being prepared for publication. The three most important fibre-producing agaves, *A. sisalana*, *A. fourcroydes* and *A. cantala* are polyploid species. The examination of *A. angustifolia*, *A. amaniensis* and *A. Lespinassei* gives a somatic number of 2n = 60 which is in agreement with

the finding of McKelvey & Sax (*Journ. Arnold Arb.* XIV 1. 1933) working on four other species of *Agave*. *A. cantala* is a triploid 2n = 90. The position in the case of *A. sisalana* and *A. fourcroydes* is not yet clear; both are apparently aneuploid species; the chromosome number, 2n, being about 138 in *sisalana* and about 144 in *fourcroydes*, both being, in all probability, 5x- in constitution.

A. amaniensis has continued to make very good progress in comparison with *A. sisalana* at Sigi.

The first plot of *amaniensis* to be planted (December, 1929) was again cut in July. The total yield of leaf from the 163 plants was 5,222 kilogrammes which gave an output of 3·5 per cent. fibre. The production of fibre from this plot (·074 ac.) to July, 1934, has been 321 kilogrammes of fibre, which is equivalent to an output of 4,340 kilogrammes of fibre per acre over a period of $2\frac{1}{2}$ years cutting. The first cut was taken when the plants were 2 years and 2 months old.

A plot of 200 plants planted in March, 1931, on Magunga Estate, Korogwe, was cut for the first time in June, 1934. A yield of 2·7 per cent. fibre from 8,438 kilogrammes of leaf was recorded. Unfortunately the adjacent rows of *A. sisalana* were not cut at the same time to afford a rough comparison of yield.

The fibre from this plot was sent to the Tanganyika Cordage Company for spinning. A report on the results of their tests has not yet been received.

A bale of 200 kilogrammes of *amaniensis* fibre was sent to Messrs. Hawkins and Tipson, London, for spinning tests with very satisfactory results.

A block of 1,000 plants growing in Amani is now ready for cutting. The fibre from this plot is to be sent to England for fine spinning tests.

Twenty-eight more plants which have been allowed unrestricted growth have poled. Before it was known that *A. amaniensis* would produce seed on the normal inflorescence, several poles were cut back at varying stages of development. The buds in the axils of the lower bracts, which do not normally develop, were forced into growth but all broke off when the flowering stage was reached; the branches, at the point of insertion on the main stem, being very thin and brittle.

Suckers, retaining their connexion with the poling parent plant, have in several more cases developed miniature poles. The small poles bear flowers, fruits, and a good crop of bulbils in due course. Several cases have been observed where bulbils have developed miniature poles; these however have not developed flowers, secondary bulbils only being formed. Also a number of bulbils have been observed which have developed a terminal flower instead of a vegetative bud. Various stages of differentiation of the leaves of bulbils, still attached to the parent, into floral parts have also been noted.

Sterility.—A study of the flowering of *A. amaniensis* and *A. angustifolia* throws some light on the comparatively small proportion of fruits set under natural conditions in East Africa. The stigma of any given flower does not become receptive until the third day after its anthers have dehisced. The anthers of *amaniensis* burst about 6.0 p.m. (local time) and those of *angustifolia* about 5.0 p.m. Crowds of bees are attracted to the inflorescence and in a very short time all pollen has been removed. As most of the flowers on any given branch have shed their pollen in about four days the only stigmas having a fair chance of pollination are those of the earliest opening flowers in any group.

Artificial pollination ensures a very much greater set of fruits.

The cause of sterility in *A. sisalana* under normal conditions is still obscure. A large proportion of the pollen is fertile and a study of the ovaries of pollinated flowers before abscission shows a number of developing embryos. The problem appears to turn on the causes of cessation of activity in an abscission layer which is to be seen at the point of junction of the flower and petiole.

The following species of *Agave* have been received from La Mortola :—

A. rigida, A. filifera, A. Wercklei, A. geminiflora, A. Fransozinii var. and bulbils of *A. sisalana.*

General.

A study of selected lines of *Eleusine coracana*, in which varying degrees of sterility had been observed, has been carried out for the Department of Agriculture, Uganda.

A collection of varieties of *Vigna unginculata* is being grown and studied for the Royal Botanic Gardens, Kew.

Travelling has been confined to visits to local sisal estates and one visit to the Coffee Research and Experimental Station, Lyamungu, Moshi. I was prevented by illness from attending the meetings of Coffee Planters in Nairobi in July.

Acknowledgments.

I have gratefully to acknowledge a great deal of assistance during the year, in carrying out various investigations, from the Imperial Institute, Messrs. J. K. Gilliatt & Co., Mr. H. Tanner, Amboni Estates Ltd., Messrs. Bird & Co., Messrs. Hawkins and Tipson Ltd., the Chief Scientific Officer, Coffee Research and Experimental Station, Lyamungu, and the Senior Coffee Officer and his assistants, Department of Agriculture, Kenya.

L. R. DOUGHTY.
Plant Geneticist.

REPORT OF THE SYSTEMATIC BOTANIST.

During the period under review I was absent on vacation leave for eight months with the result that there is little progress to report in the section. Urgent matters arising during my absence were dealt with by the Director.

A total of 1,159 determinations were made on specimens received and information supplied under the following heads :—

Botanical surveys in Tanganyika Territory.
Indigenous trees and shrubs of Zanzibar and Pemba.
Ecology of pasture and grazing areas.
Browse and fodder plants including grasses.
Uncultivated host plants of insect pests.
Plants suspected of being poisonous and used in cases of criminal poisoning.
Shade trees, green manures and cover crops.
Medicinal plants used by the natives of possible interest to European Pharmacology.
Fish poison plants of possible interest as insecticides.
Ornamental exotic plants.
Tanning plants.
Parasitic plants in relation to food crops.
Plants in connexion with Bird Ecology.

This information was supplied to the following correspondents among others :—

Departments of Agriculture, Tanganyika Territory, Kenya Colony and Zanzibar.
Department of Veterinary Science and Animal Husbandry, Tanganyika Territory.
Forestry Department, Tanganyika Territory.
Medical Department, Tanganyika Territory.
Police Department, Tanganyika Territory.
Amani Staff.
Various individuals engaged in local agricultural industries.

In a collection of plants used medicinally by the natives, and received for identification, was a fish poison plant, *Mundulea suberosa* Benth. which appears to have possibilities as an insecticide. An arrow poison plant (*Sapium madagascariense* Prain) was also received, the use of which as an arrow poison has once only been recorded before, from the region of Mombasa. Unfortunately up to the present it has not been possible to obtain material of the Sapium for chemical investigation.

During my vacation leave a considerable amount of time was spent at the herbaria of the Royal Botanic Gardens, Kew, British Museum, and the Imperial Forestry Institute, Oxford, identifying specimens of cultivated plants grown at Amani, critical material from the Amani Herbarium of Leguminosae, especially *Crotalaria* and *Tephrosia*, Verbenaceae, and Orchidaceae. My thanks are due to the directors of these institutions for facilities and help in studying their respective collections.

The whole of the Amani collection of Orchidaceae was taken and with the kind assistance of Mr. Summerhayes, the Kew orchid specialist, compared with the Kew collection. Quite a number of

the species were represented poorly or not at all in the Kew collection and a selection of 65 sheets including a number of isotypes was made and presented to Kew.

With reference to the recording of the native names of plants, a stage has now been reached when it is possible to compile a list of native names with their scientific equivalents from the Index. A dictionary of Kiswahili plant names is now in the course of preparation for the Inter-Territorial Language Committee. It is proposed that it should be included as an appendix to a Kiswahili-English Dictionary that is ready for publication.

Type Species.

When determining specimens for various departments and individuals a further 29 isotypes were found in the Herbarium and recorded.

Only one new species appears to have been described from the Herbarium during the year :—

Bracteola orientalis C.E. Hubbard in Kew Bull. 1934 p. 117 (Gramineae) Tanganyika Territory, Staples 407, type.

This new species brings the total number of type specimens recorded in the Amani Herbarium up to 201 isotypes.

Contributions.

During the year, 46 contributions were received representing a total of 2,683 specimens. They were sent in by :—

The Department of Agriculture, Tanganyika Territory, communicated by the following officers :—Messrs. Davies (Tukuyu), Eyre (Tanga), Gillman (Mwanza and Bukoba), Harris (Morogoro), Musk (Dar es Salaam), Ritchie (Moshi), Rounce (Mwanza), Sanders (Moshi), Sturdy (Arusha), Thomas (Lushoto), and Wallace (W. Usambaras)	486
The Department of Veterinary Science and Animal Husbandry, Tanganyika Territory, communicated by the following officers :—Messrs. Emson (Musoma), Hornby (Mpwapwa), Lewys Lloyd (Mwanza) and Staples (Grassland areas of Tanganyika)	180
Amani Staff	623
The Royal Botanic Gardens, Kew	872
The British Museum (Natural History)	279
The Medical Department (Laboratory Service), Tanganyika Territory	16
P. R. O. Bally, Esq., Tanga, Tanganyika Territory	153
Mrs. E. Ward, Iheme, Iringa Province, Tanganyika Territory	68
Miscellaneous	6
Total	2,683

Mrs. Ward's collection from Iringa Province contains a number of interesting and little known orchids and her collection was of additional value in that each specimen was accompanied by a crayon drawing.

Exchanges.

Botanical material was exchanged with and distributed to the following institutions :—

From : The Royal Botanic Gardens Kew (including named East African material collected in Uganda, Kenya and Tanganyika)	872
The British Museum, Natural History (named material collected by B. D. Burtt, Esq. in Tanganyika)	279
Total received	1,151
To : The Royal Botanic Gardens, Kew	481
The Department of Agriculture, Kenya ...	2
The Analytical Chemist, Medical Department, Tanganyika Territory	3
Prof. E. B. Babcock, University of California, U.S.A.	4
The Department of New Cultures, Leningrad, U.S.S.R.	2
Dr. Deland, Bougainville, New Guinea ...	1
Total distributed	493

Loan of Specimens.

Specimens and types were loaned to :—

The British Museum (Natural History).	91 sheets of *Combretum* spp.
The Royal Botanic Gardens, Kew.	37 sheets of East African Gramineae.
Prof. E. B. Babcock, University of California, U.S.A.	11 sheets of *Crepis* spp.
Prof. W. Trelease, University of Illinois, U.S.A.	13 sheets of Agavaceae.

Field Work.

There is nothing to report on in regard to field work, except that a short visit was made near Mombo at the foot of the West Usambaras to report on a collection of native drugs and medicinal plants.

P. J. GREENWAY,
Systematic Botanist.

ORNITHOLOGICAL WORK.

Attention during the year has been focused mainly upon three lines of investigation: geographical distribution, ecological relations, and the food of certain species.

Incidentally it has been possible to collect a certain amount of data on most of the questions of bird-biology referred to in Section II of my report last year. As a result of team work a good deal was learnt regarding the breeding biology of a large Hornbill, *Bycanistes cristatus*. Its peculiar habits are of great interest and few observations are on record for any of the family. A paper on "The Breeding Habits of Hornbills" was read on my behalf at the Nairobi Scientific Meeting in November, 1934, and will be published later with the addition of another season's observations.

Visits were made by two ornithologists, Messrs. D. Lack and L. S. V. Venables, both of whom stayed at Amani for several weeks. Their experience in higher latitudes led to a valuable interchange of views. Two main facts were emphasized: the advantage that the African field-worker enjoys in having large blocks of untouched country where he can observe undisturbed natural conditions; and the disadvantage under which he often labours from the nature of the vegetation and the complexity of the environments.

During the year, two new forms have been described from our collections (*Bull. B.O.C.*, Vol. 55, pp. 13 and 14, 1934):—

ZOSTEROPIDAE.—*Zosterops winifredae* Sclater and Moreau, from the South Paré Mountains.

ESTRILDINAE.—*Cryptospiza salvadorii kilimensis* Sclater and Moreau, from Kilimanjaro.

Geographical Distribution.

A little further collecting has been done in the Kilimanjaro region and a special search has been made for certain critical forms. A paper has been completed under the title "A Contribution to the Ornithology of Kilimanjaro and Mount Meru".

Good progress has been made with the investigation of the ornithologically unknown areas referred to in Section III of my last year's report.

The opportunity is taken to acknowledge the assistance received from several officers of the Tanganyika Government in facilitating the work of collecting. I must particularly refer to Messrs. H. C. M. Potts and B. Leechman of the Administration; and Messrs. E. D. Maber and F. J. Ross of the Forest Department.

An African collector has obtained about 300 specimens from the top of the North Paré and South Paré Mountains, where no collecting has been done before. Identifications are not yet complete; but the results are certainly unexpected and they indicate that the problem of avifaunal distribution in this part of Africa is even more complicated than had been supposed.

The South Paré and West Usambara Mountains, which both rise very steeply to a height of about 7,000 feet, are separated by the Mkomasi Valley, less than 20 miles wide. The floor of the valley is only 1,500 feet above sea-level and lies in a rain-shadow, with the result that its climate is tropical as well as arid, and its vegetation is an extremely dry form of thorn-bush. It is of interest to find that the avifauna of this narrow gap has very strong Somali affinities derived by way of the Taru Desert—Tsavo strip. The Mkomasi Valley forms the southernmost extension of this Somali fauna, several species of which have not hitherto been reported from Tanganyika Territory.

Thanks to a grant from the Godman-Salvin fund to cover transport, and to facilities given me by the Director, it has been possible to work the mountains along the Rift Valley in Northern Tanganyika sufficiently for a clear idea to be formed of their avifauna and its affinities. As a preliminary a native collector obtained about 300 skins from the Mbulu mountains on the top of the western wall of the Rift and from Oldeani. Subsequently I spent the month of January in the area. About 200 more skins were obtained from Oldeani, Mbulu and also Ufiome Mountain. I am indebted to Major Fr. H. Braunschweig of Oldeani for generous assistance in connexion with both collecting trips.

I find that although Ufiome is separated from the other two mountain masses by the Rift Valley it possesses essentially the same avifauna, which differs in important respects from that of Kilimanjaro and Meru about 100 miles away to the east. The Mbulu group contains a number of forms hitherto known only from much further west, in the Kivu-Bukoba area, and others belonging to the Kenya Highlands but not known on Kilimanjaro. These peculiarities, in conjunction with the fact that Colobus monkeys appear to be absent from the Mbulu group, indicate that an important faunal line runs somewhere between Meru and the Rift Wall. A brief reconnaissance on Essimingor, which is just on the eastern side of the Rift, has sufficed to show that its avifauna, unlike that of Ufiome, belongs to the Kilimanjaro group.

It is hoped that ultimately it will be possible to prepare a comprehensive statement of the distribution of the various " island " mountain and forest forms. Considered in relation to environment and degree of isolation their subspecific variation provides a mass of curious material for the evolutionist.

Ecological Work.

The results of local investigation have appeared in the *Journal of Ecology* under the title " A Synecological Study of the Usambara Mountains, Tanganyika Territory, with particular reference to Birds." I have also taken each of the approximately 400 forms resident in Usambara and defined the ranges of each in terms of the potentially significant variables of the environment. It is proposed to deposit copies of this list at the Natural History

Museum as a body of raw material available for students of the ecological limitations of birds.

I have utilized it myself, in conjunction with the synecological study referred to above, to prepare a "Critical Analysis of the Distribution of Birds in a Tropical African Area," which has been accepted for publication in the *Journal of Animal Ecology* for November, 1935. This paper provides an examination on local data of the extent to which the several biotic and climatic factors may be effective in limiting the ranges of birds.

Food Investigations.

In past annual reports I have expressed myself pessimistically as to the chances of obtaining the entomological co-operation necessary for this work. During the year under review the prospect has been changed however by the fact that Mr. W. Nowell has been able to devote a certain amount of time to the investigation.

It has been decided to concentrate mainly on two species of Weaver-bird, a Golden Weaver, *Ploceus aureoflavus*, and a Spot-back (Black-headed), *Ploceus nigriceps*, belonging to a family of obvious economic importance. The species selected are abundant, easily collected and generally regarded as agricultural nuisances.

The intention is to obtain stomach material in small batches distributed over a period of two years. About 120 specimens have been examined up to the present; and on this basis the opinion has been formed that both species are far less harmful than has commonly been supposed. Indeed from the amount of insects taken at certain seasons, especially weevils and orthoptera, it is possible that on balance the birds should not be classified as harmful. With a species that divides its attention between harmful insects, the seeds of crops, and the seeds of wild plants it is of course most difficult to strike a balance; in fact a detailed evaluation of its status is only too likely to be illusory. The question will be dealt with more fully when all the data are available.

R. E. MOREAU.

REPORT OF THE SUPERINTENDENT OF PLANTATIONS.

I was absent on vacation leave from the commencement of the period under review until 16th November. During my absence the work was carried on by the Engineer with the assistance of Mr. T. A. Baldock, a local planter, who was engaged for temporary duty and had charge of plantation work.

While on leave arrangements were made for me to visit the well-known Botanic Gardens at La Mortola. A large number of economic and other plants were collected. These included eight named *Agave spp.*, 11 *Aloe spp.* and two species of Pelargonium.

I wish to record my appreciation of the assistance rendered to me by the Curator, Mr. S. McLeod Braggins, and to Major Johnson of Mentone, both of whom made it possible for me to visit many botanical collections.

Construction and Maintenance.

The following are the main items under this heading :—

1. The addition, for the Plant Pathologist, of a third greenhouse for virus work, and the glazing in of the pathology laboratory verandah.

2. The large open verandah of the Plant Physiologist's laboratory built up and glazed for use as a greenhouse.

3. A new Coltman boiler, purchased from Tanganyika Railways, erected and fitted up in the Nursery for soil sterilization in connexion with the Quarantine houses and secondary use for the distillation of essential oils.

4. A two-roomed dwelling built for use as an official guesthouse.

5. The block, comprising the general office, post office, guesthouse and store-rooms demolished and the erection of a new building commenced. The new block includes provision for the general office, Secretary's office, store-rooms, post office, and a new laboratory for the Geneticist.

6. The old galvanized shed enclosed, and extended to accommodate the fitter's and carpenters' workshops. The sisal decorticating machinery, consisting of a raspador and " Cormorant " decorticator, has been installed in this building, the necessary power being provided by a 12 h.p. Lister engine.

7. The necessary repairs to officers' quarters have been carried out, including the glazing in of the verandah of the Geneticist's house.

Transport.

A new Bedford lorry chassis was purchased, and the body built in the Amani workshops.

The old Chevrolet lorry and the Oakland touring car were disposed of. All general repairs to the Station's lorries were carried out in the Station workshops.

Roads.

The maintenance and control of the Amani-Muhesa road continues to be undertaken by the Station.

The wooden decking of the culvert at mile 1·5 and of the bridge at mile 16·7 were removed and replaced with concrete. Heavy rains at the beginning of March caused a land-slide from the upper bank at mile 15 and necessitated the closing of the road for six days. Considerable damage was also done at this time to the whole

of the section from Sigi to Amani. A special grant from the Public Works Department enabled the work of clearing and repairing the road to be completed without delay.

Kwamkoro Coffee Estate.

The total crop for the year was 16 tons of parchment and 1½ tons of clean *Coffea arabica*, and 1¾ tons of clean *Coffea robusta*.

Work on the old *Coffea arabica* plantations consisted only of cleaning through with bush knives.

The extension of the *Coffea robusta* plots on the Mlesa plantation has been continued, 12 acres having been planted during the year. A small plot of one acre has also been planted near the factory.

Preparations have now been made for more extensive areas to be planted with selected *Coffea robusta*. For this purpose a nursery has been planted with 40,000 seedlings near the factory, and a smaller nursery at the lower end of the Mlesa plantation with 20,000 seedlings. These should be ready for planting in their permanent quarters in March, 1936.

Plantations and Nurseries.

Work in the plantations and nurseries has consisted chiefly of the raising of plants of important economic crops considered suitable for local conditions, the growing and collecting of material for the Biochemist's investigations of insecticides and essential oils, the collecting of *Agave spp.* and the raising of planting material of the different fibre-producing plants for the new Sisal Experimental Station. Much work has also been involved in raising and collecting other economic plants to supply the requests of planters and Agricultural Departments. In this connexion it will be noticed that a considerable increase has taken place during the year in the distribution of plants and seeds.

Tung Oil trees. *Aleurites montana* still proves itself to be well suited by the conditions at Amani, while *A. Fordii* definitely refuses to make any appreciable growth. A second small plot of *A. montana* was planted out during the year. Both plots are now doing well. The two trees of *A. montana* in the original nursery beds have again fruited and 5,000 seeds have been planted in bamboo pots for establishing a much larger area in the Kwamkoro plantations.

Ramie. Successions of plantings of Ramie have been made for the supply of root divisions for distribution to planters.

Cinchona. The 3,000 *Cinchona ledgeriana* seedlings mentioned in the last report have been planted as refills in the old Cinchona plots. A quantity of seed of *C. ledgeriana* and *C. succirubra* has been sown. It is intended to carry out experimental grafting of *C. ledgeriana* on *C. succirubra* stocks and to extend the Cinchona plantings on a larger scale in the Kwamkoro plantations.

Coffee. In addition to raising 60,000 *Coffea robusta* seedlings from selected seed for the Kwamkoro nurseries, 25,000 seedlings

have also been raised and planted in the Amani nursery beds as stocks for grafting *C. arabica.*

Cover Crops. Seed of some 20 species from the collection of cover crops has been sent to the new Coffee Experimental Station, Moshi. Other species will be sent as soon as seed becomes available. On the completion of this it is intended to discontinue the growing of cover crops for seed distribution at this Station.

Tuba Root. 3,000 plants of *Derris elliptica* have been planted in bamboo pots, while another 4,000 cuttings have been planted in nursery beds for eventual planting out in the Kwamkoro plantations. The small plot in the nursery has also been extended to meet the demand for cuttings from planters and Agricultural Departments in East Africa.

Yerba Mate (*Ilex paraguensis*). 250 lb. of Paraguay tea has been prepared and is being sent to England for trial purposes. 150 plants have been raised for the extension of the existing plot.

Sisal. 17,678 suckers and 5,450 bulbils of *Agave amaniensis* have been supplied to the Sisal Experimental Station at Mlingano, Muhesa. Material of the different species of Agave in the Amani collection is also being supplied as soon as sufficient room for planting has been cleared. 2,000 bulbils and suckers of *Agave amaniensis* were distributed to planters in Kenya and Tanganyika.

The seedlings of *Agave sisalana* raised from seed obtained from Longonot, Kenya, mentioned in the last annual report have been planted out in the Sigi plantations.

Sugar. The plots of sugar-cane mentioned in the last report continue to grow well. For other imported canes see under Plant Quarantine.

Tea. The whole of the tea plots pruned and grown for seed-bearing are now fruiting, but in view of the restrictions on planting the seed is not likely to be in demand.

Plant Quarantine.

Cassava varieties have been received from the Gold Coast (two), Jamaica (six, of which four survive) and Trinidad (six).

Sugar-cane varieties. Mayaguez 28 was imported on two occasions from Porto Rico but was dead on arrival; of Mayaguez 7, imported from Porto Rico, one set is growing.

The following canes have been transferred from the plant reception houses to the observation house :—HM.320, HM.606, Mayaguez 42, Mayaguez 702, B.726, B.891, B.2935, B.3013, B.3172, B.3254, B.3257, and B.A.11569.

Plant and Seed Introduction.

34 packets of seeds.
9 packets Fern spores.
394 bulbils of *Agave fourcroydes.*
44 bulbils of *Agave sisalana.*

20 bulbils of *Agave rigida.*
8 plants named *Agave sp.*
11 plants named *Aloe sp.*
134 miscellaneous plants.
15 bulbs *Lilium formosanum.*
5 corms *Richardia pentlandii.*
Cuttings of 4 species of ornamental plants.
441 packets of seeds.
400 lb. Tea seed.
72 lb. *Maesopsis Eminii.*
58 lb. Kapok.
27 lb. *Coffea robusta.*
14 lb. *Allanblackia Stuhlmannii.*
9 lb. *Coffea arabica.*
6 lb. *Coffea liberica.*
6 lb. *Tephrosia Vogelii.*
5 lb. *Trema guianensis.*
5 lb. *Lantana camara.*
4½ lb. *Schizolobium excelsum.*
3½ lb. Cocoa seed.
2 lb. *Parkia filicoidea.*
2 lb. *Samanea Saman.*
1½ lb. *Albizzia sassa.*
1½ lb. *Cinnamomum zeylanicum.*
1 lb. 6½ oz. Cinchona seed.
1 lb. *Eucalyptus maculata.*
1 lb. *Eucalyptus robusta* seed.
1 lb. *Eucalyptus rostrata* seed.
½ lb. Pepper seed.
½ lb. *Podocarpus usambarensis.*
½ lb. *Eugenia Jambos.*
½ lb. *Coffea quillou.*
214 Camphor plants.
77 miscellaneous plants.
1 box and 150 cuttings of miscellaneous plants.
22 cuttings and suckers of Bamboos.
25,128 bulbils and suckers of *Agave amaniensis.*
468 lb. Ramie root divisions.
4 cwt. and 99 cuttings of Uba Cane.
54½ boxes Lemon Grass roots.
25 boxes Khus Khus roots.
1 box *Cynodon dactylon* roots.
1,142 cuttings of Pepper.
800 cuttings of *Derris elliptica.*

6 cwt. of *Allanblackia Stuhlmannii* seeds were collected, dried and sent to an English firm for investigational purposes.

F. M. ROGERS,
Superintendent of Plantations.

REPORT OF THE SECRETARY AND LIBRARIAN.

The work of the office during the year proceeded smoothly and calls for little comment. The increased number of visitors to the Station during the year, especially those staying here for a period, naturally meant an addition to the office work in accommodating them and supplying their requirements.

The report of the Conference of East African Soil Chemists held at Zanzibar in August, 1934, was prepared by Mr. G. Milne, as secretary to the conference; and after his departure on leave the final arrangements for publication were made here in consultation with the Secretary, Conference of East African Governors.

As mentioned in the Director's report the position of the Amani Library as the central scientific reference library for East Africa received recognition in the most practical and munificent manner towards the end of the year by the grant of £10,000 from the Carnegie Corporation as a permanent endowment. Under the management of the Crown Agents for the Colonies the capital is estimated to bring in an income of about £325 a year.

The increased sum available for 1935 has made it possible for the first time to consider the distribution of a printed catalogue, the absence of which in the past has been an obstacle to the utilization of the library by the workers scattered over the wide area of the contributing dependencies. The preparation of the catalogue has been completed and we are now awaiting printers' quotations. It is the intention to distribute copies to all research stations and to all agricultural offices in the contributing dependencies.

During the year the expansion of the Library was satisfactory. At the end, in addition to the 84 journals and annuals received by subscription, the Library was in exchange relations with 189 different institutions and departments. A particular effort has been made to supplement the existing African periodicals; and the generous response made by the Museums at Cape Town, Durban and Pretoria is worthy of record. Within the field of tropical agriculture the most important acquisitions have been Dutch East Indian publications, of which the Library now possesses very fine series. The number of books added during the year was 92.

R. E. MOREAU,

Secretary and Librarian.

APPENDIX A.

FINANCIAL STATEMENT FOR THE YEAR ENDED 31st DECEMBER, 1934.

Revenue.

Ordinary Recurrent Revenue :—	£	£
H.M. (Imperial) Treasury	6,000	
Contribution, Tanganyika Territory	6,000	
,, Uganda	1,800	
,, Kenya	1,700	
,, Zanzibar	1,200	
,, Northern Rhodesia	300	
,, Nyasaland	300	
	17,300	
Local Sales &c.	356	
Total Recurrent Revenue		17,656
Extraordinary Revenue :—		
Levy on Salaries	643	643
		£18,299

Maintenance Expenditure.	£	£
Personal Emoluments	11,180	
Passages	749	
Pensions Contributions	1,910	
Laboratories	1,145	
Library and Publications	417	
Office, Telephone Rent, and Contingencies	227	
Materials	577	
Freight and Transport	379	
Travelling	455	
Labour	1,197	
		18,236
Balance on the year's working		£63

Summary.	£	£
Recurrent Revenue	17,656	
Extraordinary Revenue	643	
Credit Balance on 1st January, 1934	3,054	
Total		21,353
Maintenance Expenditure	18,236	
Expenditure from Reserve (new lorry)	131	
Total		18,367
Credit balance on 31st December, 1934 (agreeing with statement furnished by the Treasurer, Tanganyika Territory)		2,986

Note.

The following items of capital expenditure have been approved as a charge against the above credit balance :—

	£
Reconstruction of buildings	500
Supplementing Hydro-electric Plant	750
Total	£1,250

Kwamkoro Coffee Estate.

Crop Expenses :—

	£	£
Labour	132	
Materials	8	
Freight and Transport	137	
	277	
Other Expenses :—		
Materials	65	
Labour (Maintenance, repairs, development)	405	
		747

Receipts during 1934.

Sale of Coffee—mostly 1933 crop	160
	587
Credit balance brought forward from 1933	754
Cash position on 31st December, 1934 credit	£167

Other Assets.

Estimated proceeds of 1934 crop to be sold in 1935	£850

APPENDIX B.

LIST OF PUBLICATIONS BY EAST AFRICAN AGRICULTURAL RESEARCH STATION.

1. Records of Butterfly Migration in East Africa. C. B. Williams, *J. E. A. & Uganda Nat. Hist. Soc.*, No. 35, pp. 1-16, 1929.
2. Collected Records relating to Insect Migration, First and Second Series. C. B. Williams, *Trans. Ent. Soc., London*, Vol. 77, pp. 79-91, 1928; Vol. 79, pp. 139-170, 1930.
3. Locust-hoppers and Birds in East Africa. R. E. Moreau, *Bull. Ent. Res.*, Vol. 21, Part 2, pp. 141-145, 1930.
4. The Bird-population of a Settled Valley in the West Usambaras, Tanganyika Territory. R. E. Moreau, *J. Ecol.*, Vol. 19, No. 1, pp. 64-74, 1931.
5. The Filtration of the Virus of Streak Disease of Maize. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 1, pp. 1-5, 1932.
6. The Estimation of Carbon in Plant Tissues. R. R. Worsley & F. J. Nutman, *Ann. Bot.*, Vol. 45, No. 180, pp. 693-707, 1931.
7. A Bark Disease of Coffee in East Africa. H. H. Storey, *Ann. Appl. Biol.*, Vol. 19, No. 2, pp. 173-184, 1932.
8. Vegetation of Mpwapwa, Tanganyika Territory. P. J. Greenway, *J. Ecol.*, Vol. 21, No. 1, pp. 28-43, 1933.

9. Pleistocene Climatic Changes and the Distribution of Life in East Africa. R. E. Moreau, *J. Ecol.*, Vol. 21, No. 2, pp. 415-435, 1933.

10. On the Food of the Red-billed Oxpecker. R. E. Moreau, *Bull. Ent. Res.*, Vol. 24, Part 3, pp. 325-335, 1933.

11. The Inheritance by an Insect Vector of the Ability to Transmit a Plant Virus. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 112, pp. 45-60, 1932.

12. A Sulphur-deficiency Disease of the Tea Bush. H. H. Storey, *Ann. Appl. Biol.*, Vol. 20, Part 1, pp. 23-56, 1933.

13. A Note on the Distribution of *Gypohierax angolensis* (Gmel.), the Vulturine Fish-eagle. R. E. Moreau, *J. Animal Ecol.*, Vol. 2, No. 2, pp. 179-183, 1933.

14. Observations on the Desert Locust in East Africa from July, 1928, to April, 1929. C. B. Williams, *Ann. Appl. Biol.*, Vol. 20, No. 3, pp. 463-497, 1933.

15. A Contribution to Tropical African Bird-Ecology. R. E. Moreau, *J. Animal Ecol.*, Vol. 3, No. 1, pp. 41-69, 1934.

16. A Chemical Survey of the Waters of Mount Meru, Tanganyika Territory, especially with regard to their qualities for Irrigation. D. Sturdy, W. E. Calton & G. Milne, *J. E. A. & Uganda Nat. Hist. Soc.*, No. 45, pp. 1-38, 1933.

17. Investigations of the Mechanism of the Transmission of Plant Viruses. H. H. Storey, *Proc. Roy. Soc. B.*, Vol. 113, pp. 463-485, 1933.

18. Root-systems of *Coffea arabica*, Parts I and II. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 1, pp. 271-284, 285-296, 1933.

19. Taxonomic and Field Notes on Some Birds of North-East Tanganyika Territory. W. L. Sclater and R. E. Moreau, *Ibis* (Ser. 13, Vol. 2), pp. 487-522, 656-683, 1932; (Ser. 13, Vol. 3) pp. 1-33, 187-219, 399-440, 1933. (Limited distribution only.)

20. Some East African Essential Oils. R. R. Worsley, *Bull. Imp. Inst.*, Vol. 32, pp. 253-270, 1934.

21. The Insecticidal Properties of some East African Plants. R. R. Worsley, *Ann. Appl. Biol.*, Vol. 21, pp. 649-669, 1934.

22. Root-systems of *Coffea arabica*, Part III. F. J. Nutman, *Emp. J. Exp. Agric.*, Vol. 2, pp. 293-392, 1934. (An advance distribution of this paper has been made to East African Departments of Agriculture.)

23. The Photodynamic Action of Methylene Blue on the Virus of a Plant Disease. H. H. Storey, *Ann. Appl. Biol.*, Vol. 21, pp. 588-589, 1934.

(32118—48) Wt. P2061—3509 1125 11/35 P.St. G. 377/7